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principle but from the facts of experience. Dr. Harris calls Space, Time, Causality "presuppositions of experience": they make experience possible. We consider them as parts of experience as characteristic properties, and our concepts of time, space, and causality have been abstracted from experience. Dr. Harris says: "Space in limiting itself is infinite . . . time is infinite, and yet it is the condition necessary to the existence of events and changes. . . . The principle of causality implies both time and space. . . . If we examine it, we shall see that it again presupposes a ground deeper than itself. In order that a cause shall send a stream of influence over to an effect, it must first separate that portion of influence from itself. Self-separation is, then, the fundamental presupposition of the action of causality. . . . Causa sui, spontaneous origination of activity, is the ultimate presupposition underlying all objects and each object of experience. . . . Causa sui, or self-cause, is properly the principle *par excellence* of philosophy. . . . Here is the necessary ground of the idea of God." In the last chapter Dr. Harris discusses "the immortality of man," denoting thereby the immortality of the individual and the continuance of consciousness after death. He expresses his argument in admirable terseness in the following sentence: "How is it possible that in this world of perishable beings there can exist an immortal and ever progressive being? Without the personality of God it would be impossible, because an unconscious first principle would be incapable of producing conscious being, or if they were produced, it would overcome them as incongruous and inharmonious elements in the world. It would finally draw all back into its image and reduce conscious individuality to unconsciousness." This is a different solution of the problem from that presented in the article "The Origin of Mind" in the first number of this magazine. κ.

THE EVOLUTION OF SEX. By Prof. *Patrick Geddes* and *J. Arthur Thomson*. New York: Scribner & Welford.

The present work is in some sense a reproduction of the articles "Reproduction," "Sex," and "Variation and Selection," contributed by Professor Geddes to the most recent edition of the "Encyclopædia Britannica." It goes further, however, and not only contains much additional information, but the views of the authors on the factors of organic evolution and on biology in general are more precisely formulated and developed. The central thesis of the work, as stated in the preface, is "in the first place, to present an outline of the main processes for the continuance of organic life with such unity as our present knowledge renders possible; and in the second, to point the way toward the interpretation of these processes in those ultimate biological terms which physiologists are already reaching as regards the functions of individual life,—those of the constructive and destructive changes (anabolism and katabolism) of living matter or protoplasm." The authors seek to prepare the way for the restatement of the theory of organic evolution, that of "definite variation, with progress and survival essentially through the subordination of individual struggle and development of species-maintaining ends."

Among the subjects treated of are Sexual characters and the determination of Sex, the analysis of Sex-organs, tissues, and cells—the nature and origin of Sex, and the processes and theory of reproduction. This is a sufficiently broad field, and it embraces various biological questions recently discussed, especially that of sexual selection and the theories of Professor Weismann. The authors claim that their view of the processes concerned with the maintenance of the species leads necessarily to a profound alteration of the conclusions usually held as to its origin. What is meant by this statement appears from the last chapter, in which the reproductive function as a factor in evolution is considered. Here it is stated that the usual perspective which places the theory of natural selection in the foreground, sexual selection being a mere harmonious corollary, has to be reversed. Recent investigations on heredity "forbid that attention should any longer be concentrated on the individual type, or reproduction regarded as a mere repetition process; the living continuity of the species is seen to be of more importance than the individualities of the separate links. . . . The species is a continuous undying chain of unicellular reproductive units, which indeed build out of and around themselves transient multicellular bodies, but the processes of nutritive differentiation and other individual developments are secondary, not primary" (p. 308).

The study of the reproductive process is thus of supreme importance for the understanding of organic evolution. What then is the authors' theory of reproduction? It may be stated in the terms of their own summary. The essential fact in reproduction is the separation of part of the parent organism to start a fresh life. Hence, it begins with rupture, a katabolic crisis, at which occurs cell-division, this being always associated with the act of reproduction. This is favored by katabolic conditions of the environment. The opposition between nutrition and reproduction is the most obvious antithesis in nature after that of life and death—with the latter of which, indeed, as has been shown by Goette, reproduction is intimately associated—and it may be stated in the terms that "as a continued surplus of anabolism involves growth, so a relative preponderance of katabolism necessitates reproduction" (p. 237).

The organic relation between nutrition and reproduction is thus shown to be one of great importance, but its significance becomes more apparent when it is seen, as pointed out by the authors, that "throughout organic life there is a contrast or rhythm between growth and multiplication, between nutrition and reproduction, corresponding to the fundamental organic seesaw between anabolism and katabolism. This contrast may be read in the distribution of organs, in the periods of life, and in the different grades of reproduction; and the contrasts between continuous growth and discontinuous multiplication, between asexual and sexual reproduction, between parthenogenesis and sexuality, between alternating generations, are all different expressions of the fundamental antithesis" (p. 231). Elsewhere, the essential importance is referred to of "the continual correlation, yet antithesis—the action and reaction—of vegetative and reproductive processes in al-

ternate preponderance," to which the general rhythm of individual and social life runs parallel. And yet this life is essentially a unity, of which the specific characters are but the symptoms, whatever may be "their subsequent measure of importance and utility in adaptation, their modification by environment, their enhancement or diminution by natural selection" (p. 314).

This conclusion as to the unity of the life of the individual and that of the species, is based on the fact that nutrition and reproduction are nearly akin. Hatschek goes so far, indeed, as to affirm that nutrition is reproduction, an apparent paradox which is justified by the statement that "not only do hunger and love become indistinguishable in that equal-sided conjugation which has been curiously called 'isophagy,' but nutrition in turn is nothing more than continual reproduction of the protoplasm." The real unity is found in the fact that anabolism and katabolism, which are the determining factors of growth and reproduction, are the two sides of protoplasmic life. This conclusion has an important bearing on the question of the origin of sex. In his theory of *genoblasts*, or sexual elements, Minot treats male and female as derivatives of primitive hermaphroditism in two opposite directions, the differentiation taking place "by the extrusion or separation of the contradictory elements, the ovum getting rid of male polar globules, the sperm leaving behind a female mother-cell remnant." The authors of the present work accept this view, which however has become extremely improbable since Weismann has called attention to the fact that the same process takes place in the parthenogenetic summer-eggs of Daphnidae—a fact which has been overlooked by our authors. They also adopt Rolph's view that the less nutritive, and therefore smaller, hungrier, and more mobile cells are what we call male; the more nutritive and usually more quiescent cell being the female, as consistent with the conclusion already inferred from other facts that "the female is the outcome and expression of preponderant anabolism, and in contrast the male of predominant katabolism" (p. 132). This conclusion is elsewhere stated as that "the males live at a loss, are more *katabolic*,—disruptive changes tending to preponderate in the sum of changes in their living matter or protoplasm. The females, on the other hand, live at a profit, are more *anabolic*,—constructive processes predominating in their life, whence indeed the capacity of bearing offspring" (p. 26). Here is the same contrast as that seen in the alternating phases of cell-life, of activity and repose, and in the great antithesis between growth and reproduction. The argument is put into diagrammatic form, where the sum-total of the functions are divided into nutritive and reproductive, the former into anabolic and katabolic processes, and the latter into male and female activities. This theory of Rolph, if it contains a grain of truth, needs a thorough revision; and the same may be said about the authors' special theory, which is, that there is a parallelism in the two sets of processes, "the male reproduction is associated with preponderating katabolism, and the female with relative anabolism, according to which view both primary and secondary sexual characters express the fundamental physiological bias characteristic of either sex"

(p. 27). This has a special bearing on the question of sexual selection, the true relation of which to natural selection, according to the authors of the present work, must be expressed in their own words. It is embodied in the conclusion that sexual selection is a minor accelerant, natural selection a retarding 'brake,' "on the differentiation of sexual characters, which essentially find a constitutional or organismal origin in the katabolic or anabolic diathesis which preponderates in males and females respectively" (p. 31).

Before concluding this notice, it may be pointed out what are the particular conditions on which the determination of sex depends, in regard to any given organism. The various suggestions proposed as to the influence of parents, according to age or otherwise, the time of fertilisation, Starkweather's law that sex is determined by the superior parent, and that the superior parent produces the opposite sex, and Düsing's theory as to the regulation of the proportions of the sexes, are referred to by the authors and either rejected or considered as insufficient. The conclusion they arrive at after considering the influence of nutrition, temperature, and other conditions, is, that adverse circumstances affecting the parents, especially of nutrition, but also age and the like, tend to the production of males, the reverse conditions favoring females; a highly nourished ovum and fertilisation when the ovum is fresh and vigorous, tend to the development of a female rather than of a male. Further, the longer the period of sexual indifference continues, the more important become the outside factors, and here again "favorable conditions of nutrition, temperature, and the like, tend toward the production of females; the reverse increase the probability of male preponderance." This agrees with the conclusion independently arrived at that the male germs are "of smaller size, more active habit, higher temperature, shorter life, and the females the larger, more passive, vegetative, and conservative forms" (pp. 50, 51). Thus the authors' proposition that the male is the outcome of predominant katabolism, and the female of equally emphatic anabolism, might seem to be justified, and it is confirmed by the curious phenomenon of alternation of generations, and by various facts connected with growth and reproduction. However, it does not definitively exclude the theory (see Dr. Heinrich Janke's work. Stuttgart, 1889) that the male is the outcome of katabolism of the male element coincident with *anabolism* of the female element, and the female of the opposite state.

In considering the psychological and ethical aspects of sex from the physiological standpoint the authors remark truly that in order to obliterate the distinctions between male and female, it would be necessary to have evolution over again on a new basis. Although so different, however, the two sexes are complementary and mutually dependent, "not merely because they are males and females, but also in functions not directly associated with those of sex." Males, as the more katabolic organisms, are more active and variable than the anabolic females, who are more passive and stable. The former have larger brains and more intelligence, but the latter have more of the altruistic sentiment and greater constancy in affection and sym-

pathy. "Man thinks more, woman feels more. He discovers more, but remembers less; she is more receptive, and less forgetful." All this is true within certain limits, but whether or not it may be explained by other theories remains an open question. Ω .

ANIMAL LIFE AND INTELLIGENCE. By *C. Lloyd Morgan*, F. G. S. London: Edward Arnold.

The chief aim which the author of this important work had originally in view was the consideration of Animal Intelligence. But the subject of Intelligence being so closely associated with that of Life, and the questions of Heredity and Natural Selection with those of Habit and Instinct, he has devoted the first part of the work to Organic Evolution, as introductory to Mental Evolution. This was rendered necessary, however, by the direct bearing of Professor Weismann's recent contributions to biological science on questions of Instinct. It would be impossible to treat of the mental constitution of the lower animals without reference to that of man, and in his preface Professor Morgan forestals certain results arrived at by a comparison of them. He states that in man alone, and in no dumb animal, is the rational faculty, as defined by him, developed; and he adds, "it is contended that among human folk that process of natural selection, which is so potent in the lower reaches of organic life, sinks into comparative insignificance. Man is a creature of ideas and ideals. For him the moral factor becomes one of the very highest importance. He conceives an ideal self which he strives to realise; he conceives an ideal humanity towards which he would raise his fellow-man. He becomes a conscious participator in the evolution of man, in the progress of humanity."

So great a variety of topics are dealt with by the present work that we shall be able to do little more than refer critically to the author's special views, particularly those which concern the mental characters of the lower animals. There are, however, various points in the earlier part of the work well deserving of consideration. Such is the suggestion that, instead of likening an organism as a whole to a steam-engine, it would be better to liken each cell, with its fluid explosive material, to a gas-engine, and the mixed air and gas to whose explosion its motion is due. The importance of *segregation* as a factor in the formation of improved varieties is insisted on, but Professor Morgan doubts whether differential fertility, on which Mr. Romanes lays great stress*, would, without the co-operation of other segregation-factors, give rise to separate varieties capable of maintaining themselves as distinct species (p. 105).

Dealing with the knotty question whether, if the egg produces the hen, the hen produces the egg, the author criticises Professor Weismann's idea of the continuity of germ-plasm, which he regards as "an unknowable, invisible, hypothetical entity," that may be made to account for anything and everything, and prefers

* *The Monist*, No. 1. p. 5.